French Republic
Ministry of Industry
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Patent number 1 209 475
Application date August 8 1958 Paris
Allowed : September 21 1959 and published Marsh 2 1960

Valve with a sleeve like membrane for high pressure loads

Summary

The invention consists of a valve in the shape of a sleeve for high pressure loads in which exists an annular canal situated between the valve box and an internal lining body having an aerodynamic shape which is mounted concentrically in the box. This valve is closed by a sleeve like membrane that is anchored by one or both ends in the box and supported by an axial neck of the box. The membrane consists in its peripheral zone that varies during opening and closing of alternating interior and exterior grooves extending longitudinally to give a remarkable bellow effect by the following effects either individually or in cooperation:

a- The membrane consists near each neck of the box of a thickening in the shape of an annular bead with a first non sloped zone that closes the annular opening situated between the neck and the internal body of the lining like a stopper in the presence of high pressures acting on the external face of the membrane with simultaneous discharge in the peripheral direction.
b- The external wall of the membrane is bulged near the thickening so that a curvature exits on the external face of the membrane in an axial cross section in the presence of a high pressure load.
c- The thickening is made only on the external face of the membrane.

The present invention is about membrane valves for high pressure loads in which the annular canal between the valve box and the interior lining (approximately aerodynamic) mounted concentrically inside the box is closed by a sleeve like membrane.

Valves of this sort are fabricated both as check valves and inlet valves. Inlet valves of this type are generally made in such a manner that at rest the membrane is pushed against the interior wall of the box leaving open the annular canal between the box and the interior lining. The membrane is held at both ends in the box. To close the valve, One introduces a high pressure fluid in the chamber behind the membrane. This fluid presses the membrane inward towards the lining. In the case of check valves, the membrane is held only at one end in the box. It is held at rest by a small conical deformation in the annular space and maintained under low tension against the lining.

When a membrane of this kind is used as a stop valve for high pressure fluids, the wall thickness should be such it can resist the pressure. It is known that one constructs grooves in the membrane disposed alternately and laying longitudinally to obtain a bellow effect.

We noticed that when valves of this kind are loaded by an external high pressure, that is distribution pressure for closing the membrane in the case of inlet valves and return pressure for check valves, and when the interior of the membrane is subject only to small pressures or no pressure at all, the membrane is driven into the annular opening between the neck of the box and the interior lining. We also noticed that there is a danger of the membrane being driven too far through the annular opening and risk destruction. Even in the absence of sloping, there is a risk of destruction of the membrane when the grooves are extended to the shoulder or the neck of the box that holds it.

In the case of inlet valves of this kind, we also noticed a disturbing phenomenon in the presence of high pressures. The membranes of this valves have V shaped grooves extending in the longitudinal direction and the opening angle is chosen in s such a away that the limiting walls of the V shape close against each other presenting a near uniform surface when the membrane is retracted in the median zone by a distribution pressure applied on the exterior. To close a valve of this kind, in a high pressure load situation, one needs a very high distribution pressure. Low or zero pressure is encountered after closing the valve at least in the closed inlets from the pressure side. The high distribution pressure necessary for stopping the flow produces a strong curvature in the membrane in the annular opening facing the inlet. Thus the membrane is very extended by this curvature with respect to its original length. It was noticed that in the presence of this strong longitudinal extension of the membrane, the grooves open again and that a sure closure of the valve is not guaranteed in the presence of high pressure loads.

To avoid these disadvantages, the membrane of this invention is fabricated in such a way that it contains near every supporting neck of the box, a thickening in the form of a circular bead with a first sloped zone that closes the annular opening between the neck and the interior lining like a an annular stopper in the presence of a high pressure against the outside of the membrane with a discharge in the peripheral direction.

When an increasing pressure is applied on the external surface of the membrane in this configuration, the longitudinally sloped zone is applied gradually against the interior lining. If the pressure continues to rise, the non sloped beaded thickening is driven back towards the interior when receiving an initial compression. This circular bead closes the annular opening between the box neck and the interior lining like a circular stopper. Since this part is not sloped, there is no danger of driving the membrane through the annular opening. The discharge that takes place in the peripheral direction, that contributes to an initial compression of the rubber cannot initiate any drag on the surface of the circular bead that is curved in the annular opening which reduces the risk of membrane destruction. During testing membranes configured in the manner described, resisted pressures larger that 100 Kg par cm^2. We noticed, that with this new construction of the membrane, the limit of the pressure of the load is no longer determined by the membrane, but by the box, whereas in the case of the previous art with longitudinal grooves the duty pressure cannot rise above 10 Kg per cm^2 due to the thickness of the walls. In the case of check or inlet valves constructed according to this invention, when the pressure applied to the exterior of the membrane reaches high values, and thus the membrane is extended in the longitudinal direction, the opening obtained from the longitudinal grooves has no effect on the tightness of the valve because the tight

closing is done in the presence of high pressures by the non sloped thickening functioning like a circular stopper of the membrane.

The exterior wall of the membrane is advantageously bulging near the thickening in such a way that there is always an axial curvature in the presence of high pressures. The thickening is present only on the outside of the membrane. Under normal functioning conditions, the circular bead of the membrane is placed by its interior wall outside of the annular section in such a way that in the case of check valves, for opening only the sloped part functioning as a bellow and the thin lip of the membrane applied against the lining get extended. In the case of inlet valves, to close in the presence of a normal or low pressure, only the sloped part placed longitudinally between the thickenings is bulged towards the interior by the distribution pressure until it comes into contact against the interior lining. Only in the case of high pressure loads that it is necessary that the non sloped beaded part is retracted by reducing its diameter. Knowing that a contraction of the beaded part happens only when the part consisting of the longitudinal grooves of the membrane are against the interior lining, there is no danger that the extended bead during the peripheral discharge could fold or flow in different directions. Since the outside thick part has no effect on the flow, the beaded part does not generate any pressure drop inside the conduit to which the valve is attached.

Figure 1 is s longitudinal cross section of a check valve of this invention with the membrane in the resting position

Figure 2 is a half longitudinal cross section of the same valve with valve completely open.

Figure 3 is a half longitudinal cross section of the same valve in the presence of an elevated return pressure.

Figure 4 is a half longitudinal cross section of a check valve in which the membrane shows a different shape.

Figure 5 shows in longitudinal cross section the application of the invention to an inlet valve (i.e Admission valve)

In the check valve of figures 1 to 3, the box is made of an anterior element 1 and a posterior element 2. An interior lining body, aerodynamic or of an oblong shape designed by the number 6 sitting in the element 1 against four ribs 5 uniformly distributed peripherally. The anterior part 7 of the lining body 6 form one whole piece with the ribs 5 and the anterior element 1. The posterior part 8 of the lining body is attached to part 7 by a threaded rod 9 and a nut 10. The box elements 1 and 2 are joined by bolts 11 distributed around the periphery.

The annular opening 13, situated between the box element 1 and the interior lining 6 makes the actual opening of the valve. A membrane in the form of a sleeve designated by the number 14 serves to close opening 13 of the valve. This membrane 14 consists of a tight flange 15 held tightly between elements 1 and 2 of the box , a median part 16 generally conic in shape et a lip 17 formed by the free end of the membrane. The membrane 14 is shown in figure 1 at rest. This state corresponds to shape that the membrane is given during vulcanization. Only the lip 17 shown in figure 1 does not have the shape that it was given during vulcanization. The latter shape, is shown in broken line 17'. During the placement of the membrane in the valve, the lip 17 is a little extended so that it surrounds part 6 with some pressure. The anchored end of the membrane in the box is supported by a shoulder in the form of a neck 21 in the element 1

of the box. The median part 16 of the membrane consists of a thick part 18 extending outward. In addition, to enable a radial extension of the membrane under the pressure of the liquid going through the valve, the median part 16 has around all its periphery alternating internal and external notches having a width of 1millimiter after vulcanization and this corresponds at the shape at rest. The part 16a, adjacent to shoulder 21 of the thick part 10 is not sloped. The axial cross section of the valve shown in figure 1, goes through one of the external notches of the membrane 14. 19 is the bottom of this notch. The depth of the internal notch is indicated by the bottom 20 with a broken line.

Under the action of a liquid passing through the valve, from left to right, the median part 16 of the membrane 14 is extended and takes on the shape shown in figure 2. Since the membrane is made of soft material and that the lip 17 is not very thick , the latter can extend in the valve without any significant pressure drop.

Once the flow stops, the membrane comes back to its original shape shown in figure 1 in which the lip 17 is pushed with a low pressure against the interior lining 6. An increase in pressure with respect to the one on the intake of the valve is translated into a pressure at the exit of the valve. The median part of the membrane is pushed back into the opening of the valve. The shoulder 21 of the element 1 of the box supports the beginning of the median part 16 of the membrane. The thick part 18 stops the median part and the lip from being pushed back through the opening 13 during a high return pressure. Figure 3 shows the shape that the membrane has when the return pressure is very high. In one of the tests, at pressures higher than 100 Kg per cm^2 the membrane has the shape shown in fig 3. In repeated cycles to show the reliability of the construction with maximum return pressures no failure of the membrane was observed. The curvature of the thick part 18 extending outward at rest having the shape shown in figure 1 so that there still a small curvature in the position shown in figure 3. The tests showed that with the new configuration of the membrane the duty pressure is no longer limited by the membrane but by the robustness of the box.

The thick part 18 of the membrane acts like a stop for the annular opening 13. The dimensions of the thick part 18 stops it form being pushed through the opening 13 under the effect of a counter pressure . In addition, the shoulder 21 does not allow the membrane to acquire a deformation inside the opening 13. Finally the grooves 22 formed on the surface of the lining 6 oppose any relative motion between the interior surface of the membrane 14 and the lining 6.

In the shape shown in figure 4, the interior of the membrane shows a shoulder 23 supporting the shoulder 21 of the box in case of high return pressures. This configuration is particularly suited for large nominal widths with a large opening 13.

In the case of the inlet valve shown in figure 5, the valve box consists of the two end pieces 32 and 33 assembled by bolts 34. The body of the interior aerodynamic lining 35 is supported by inside the element 2 of the box by ribs 36 distributed evenly around the periphery. The annular chamber situated between the body of the interior lining 35 and the end pieces of the box 32 and 33 represents the opening of the valve its self that can be closed by the sleeve like membrane 37.

In the upper part of figure 5, the membrane 37 is shown at rest. That is the shape that it takes on when the pressures are equal on all sides. This the shape that the membrane obtains during vulcanization. At both ends, the membrane has radial parts 38 that have peripheral flanges 39. The flanges 39 fit in the corresponding cavities of the

pieces 31 and 32 of the box and serve to anchor the membrane ends. In addition, the ends of the membrane are supported by the shoulders 40 of the box. The middle part of the membrane serves to close the annular opening situated between the body of the lining 6 and the surrounding box. To enable a reduction of the diameter of the middle part 42 of the membrane under the action of a pressurized fluid introduced in the chamber 43 in the back of the membrane, the latter part of the membrane consists of alternating internal and external notches distributed uniformly around the periphery. The axial cross section of figure 5 passes through the middle of an external notch. Line 44 represents the bottom of the external notch whereas the broken line 45 represents the bottom of an internal notch. In the case of a membrane shape undisturbed by external forces, the notches present, in a transverse cross section, walls diverging outward. This divergence is chosen intentionally so that in the case of a retraction of the middle part 42 of the membrane under the effect of a hydraulic pressure introduced in chamber 43 and when the middle part is against the body of the interior lining 35, the walls of the internal and external notches are pressed against each other. When one needs to close the valve, a pressurized fluid is introduced in chambre 43. The applied pressure must be larger than the pressure in the inlet (conduit) so the middle part is pressed against the body of the interior lining 35 thus closing the valve opening. When dealing with systems with high inlet (conduit) pressures, one has to introduce a corresponding high pressure in chamber 43. Known existing valves present the danger that in the case of pressure release in the inlets (conduits), a pressure produced by a secondary source can push the regions near the end of the membrane in the annular opening. This does not happen in this invention because the parts of the membrane enabling the closing of the annular openings consist not only of thick non sloped parts 46 that is chosen dimensionally to act as a stopper in the annular opening.

The thick part 46 is fabricated on the external wall of the membrane and forms a bulge so that the external wall shows a small curvature in axial cross section of this part of the membrane in the presence of the highest pressure as indicated by figure 5. This configuration of the membrane insures that no drag takes place at the surface of the membrane thus reducing its life span. The stopper action of this thick part 46 of the membrane 37 is very well assisted by the shoulder 47 installed on the interior of the membrane in cooperation with the shoulder 40 of the box.

Other modifications can be made by one skilled in the art to the current configuration are considered as part of this invention

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